

HOW TO Write and Publish a Scientific Paper

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All seriousness aside, is there something about the use (rather than abuse) of English in scientific writing that merits special comment?

Tense in Scientific Writing

There is one special convention of writing scientific papers that is very tricky. It has to do with *tense*, and it is important because proper usage derives from scientific ethics.

When a scientific paper has been validly published in a primary journal, it thereby becomes knowledge. Therefore, whenever you quote previously published work, ethics requires you to treat that work with respect. You do this by using the *present* tense. It is correct to say "Streptomycin inhibits the growth of *M. tuberculosis* (13)." Whenever you quote or discuss previously published work, you should use the present tense; you are quoting established knowledge.

Your own present work must be referred to in the *past* tense. Your work is not presumed to be established knowledge until *after* it has been published. If you determined that the optimal growth temperature for *Streptomyces everycolor* was 37°C, you should say "*S. everycolor* grew best at 37°C." If you are citing previous work, possibly your own, it is then correct to say "*S. everycolor* grows best at 37°C."

In the typical paper, you will normally go back and forth between the past and present tenses. Most of the Abstract should be in the past tense, because you are referring to your own present results. Likewise, the Materials and Methods and the Results sections should be in the past tense, as you describe what you did and what you found. On the other hand, most of the Introduction and much of the Discussion should be in the present tense, because these sections usually emphasize previously established knowledge.

Suppose that your research concerned the effect of streptomycin on *Streptomyces everycolor*. The tense would vary somewhat as follows.

In the Abstract, you would say "The effect of streptomycin on *S. everycolor* grown in various media *was* tested. Growth of *S. everycolor*, measured in terms of optical density, *was* inhibited in all media tested. Inhibition *was* most pronounced at high pH levels."

In the Introduction, typical sentences might be "Streptomycin *is* an antibiotic produced by *Streptomyces griseus* (13). This antibiotic *inhibits* the growth of certain other strains of *Streptomyces* (7, 14, 17). The effect of streptomycin on *S. everycolor* *is* reported in this paper."

In the Materials and Methods section, you would say "The effect of streptomycin *was* tested against *S. everycolor* grown on Trypticase soy agar (BBL) and several other media (Table 1). Various growth temperatures and pH levels *were* employed. Growth *was* measured in terms of optical density (Klett units)."

In the Results, you would say "Growth of *S. everycolor* was inhibited by streptomycin at all concentrations tested (Table 2) and at all pH levels (Table 3). Maximum inhibition occurred at pH 8.2; inhibition was slight below pH 7."

In the Discussion, you might say "*S. everycolor* was most susceptible to streptomycin at pH 8.2, whereas *S. nocolor* is most susceptible at pH 7.6 (13). Various other *Streptomyces* species are most susceptible to streptomycin at even lower pH levels (6, 9, 17)."

In short, you should normally use the present tense when you refer to previously published work, and you should use the past tense when referring to your present results.

The principal exception to this rule is in the area of attribution and presentation. It is correct to say "Smith (9) showed that streptomycin inhibits *S. nocolor*." It is also correct to say "Table 4 shows that streptomycin inhibited *S. everycolor* at all pH levels."

Active Versus Passive Voice

Let us now talk about *voice*. In any type of writing, the active voice is usually more precise and less wordy than the passive voice. Why, then, do scientists insist on using the passive voice? Perhaps this bad habit is the result of the erroneous idea that it is somehow impolite to use first-person pronouns. As a result, the scientist typically uses such verbose (and imprecise) statements as "It was found that" in preference to the short, unambiguous "I found."

I herewith ask all young scientists to renounce the false modesty of previous generations of scientists. Do not be afraid to name the agent of the action in a sentence, even when it is "I" or "we." Once you get into the habit of saying "I found," you will also find that you have a tendency to write "*S. aureus* produced lactate" rather than "Lactate was produced by *S. aureus*." (Note that the "active" statement is in three words; the passive requires five.)

The passive voice could be avoided by saying "The authors found" instead of "it was found." Compared with the simple "we," however, "the authors" is pretentious, verbose, and imprecise (which authors?).

Singulars and Plurals

If you use first-person pronouns, use both the singular and the plural forms as needed. Do not use the "editorial we" in place of "I." The use of "we" by a single author is outrageously pedantic.

One of the most frequent errors committed in scientific papers is the use of plural forms of verbs when the singular forms would be correct. For example, you should say "10 g was added," not "10 g were added."